



Carnegie Mellon  
Software Engineering Institute



# **CMMI and Integrated Product and Process Development (IPPD)**

## **CMMI SE/SW/IPPD Version 1.02**

### **SEPG 2001 Tutorial**

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# Outline

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**Definition**

**Background**

**How does IPPD work in the CMMI?  
(big picture)**

**IPPD process areas**

**IPPD in SE/SW**

**Summary**



# Outline

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## → Definition

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How does IPPD work in the CMMI?  
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# CMMI IPPD Definition

**IPPD provides a systematic approach to product development that achieves a timely collaboration of relevant stakeholders throughout the product life cycle to better satisfy customer needs.**



# CMMI Integrated Team Definition-1

A group of people with complementary skills and expertise who are committed to delivering specified work products in timely collaboration. Integrated team members provide skills and advocacy appropriate to all phases of the work product's life cycle and are collectively responsible for delivering the work products as specified. An Integrated Team should include empowered representatives from organizations, disciplines, and functions that have a stake in the success of the work products.



# CMMI Integrated Team Definition-2

**An integrated team is comprised of people**

- with complementary skills and expertise
- appropriate skills and advocacy
- fully empowered to represent stakeholders
- in all phases of the work product's life cycle

**These people are committed to and collectively responsible for**

- delivering work products, as specified
- through timely collaboration



# CMMI Work Product Definition-1

Any artifact produced by a process. This may include files, documents, parts of the product, services, processes, specifications, and invoices. Examples of processes as work product include a manufacturing process, a training process, and a disposal process. A key distinction between a work product and a product component is that a work product need not be engineered.





# CMMI Work Product Definition-2

## Any artifact produced by a process

- parts of a product
- files, documents, specifications, invoices
- services
- processes, e.g., manufacturing process, training process, disposal process

**A work product is different from a product component -- it need not always be engineered**



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# IPPD Background -1

## Grew out of concurrent engineering

- Adopted by US industry in the 1980s to respond to global economic pressures
- Used teams of design and manufacturing engineers to develop the manufacturing process concurrently with the product
- Phased, parallel release
  - the manufacturing process was in place when the product design was released



# IPPD Background -2

## DoD defined concurrent engineering as

“A systematic approach to the integrated, concurrent design of products and their related processes, including manufacture and support. This approach is intended to cause the developers, from the outset, to consider all elements of the product life cycle from conception through disposal, including quality, cost, schedule and user requirements.”

*The Role of Concurrent Engineering in  
Weapon System Acquisition, Institute  
for Defense Analyses, Winner, et al.*



# IPPD Background -3

## IPPD expands on concurrent engineering and systems engineering

- Product-related processes are developed--or tailored from standard processes--concurrently with the product
- Integrated product development teams involve stakeholders spanning the product life cycle
- A disciplined systems engineering approach is applied to integrating business as well as technical functions



# IPPD Background -4

## Several DoD actions paved the way for DoD to formally adopt IPPD principles

- Defense Science Board Study (DSB) on Engineering in the Manufacturing Process
  - Based on industry success with IPPD, the DSB members recommended that DoD employ IPPD in its practices and relationships with industry
- Formation of the Defense Manufacturing Council and the Office of Systems Engineering
- Acquisition Reform activities



# IPPD Background -5

**On May 10, 1995, Secretary of Defense William Perry directed the DoD to apply Integrated Product and Process Development (IPPD) and Integrated Product Teams (IPTs) throughout the acquisition process to the maximum extent practical.**



# CMMI Project Requirements

**Provide industry and government with a set of integrated products to support process and product improvement**

- Improve the efficiency of and the return on investment for process improvement
- Reduce redundancy and complexity encountered when using multiple Capability Maturity Models® (CMM®s) and related Capability Models (CMs)
- Develop a new model encompassing the Systems Engineering and Software Engineering disciplines and IPPD concepts





# CMMI Source Models

**Combine into a single model for use by organizations pursuing enterprise-wide process improvement**

- Capability Maturity Model for Software, SW-CMM v2.0 draft C
- EIA/IS 731, Systems Engineering Capability Model
- Integrated Product Development Capability Maturity Model (IPD-CMM) v0.98



# Integrated Product Development(IPD)–CMM

## Grew out of a study of commercial and military organizations

- Focused on organizations practicing IPD with teams
- Conducted interviews for good and bad examples of IPD implementation
  - Benefits gained
  - Problems confronted
- Compiled database of results which were published by Cusick\*

\*Cusick, Kerinia. A Collection of Integrated Product Development Lessons Learned, INCOSE Conference, 1997.

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**(big picture)**

IPPD process areas

IPPD in SE/SW

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# IPPD affects all Process Areas

**IPPD is *not* a discipline.**

**Rather, it is a way of doing business.**

**IPPD is employed in conjunction with the CMMI disciplines (software and systems engineering)**

**It shapes how you perform the work in these disciplines.**



# Scope of IPPD

## CMMI SE/SW/IPPD adds to CMMI-SE/SW:

- Two totally new process areas
- A revised Integrated Project Management (IPPD) process area
- IPPD amplifications and references
- New glossary definitions and acronyms
- Overview material



# Maturity Levels

**IPPD process areas are at Maturity Level 3 in the Staged Representation**

**Amplifications and References are added to Maturity Levels 2 and 3 SE/SW process areas**

**because**

**these process areas need to be implemented differently when IPPD is being practiced**



# IPPD Fundamental Concepts\* -1

## Expressed in new IPPD process areas:

- Use of multifunctional teams
- Leadership commitment to IPPD
- Appropriate allocation and delegation of decision-making
- Organizational structure that rewards team performance

\*Cusick, Kerinia. A Collection of Integrated Product Development Lessons Learned, INCOSE Conference, 1997.



# IPPD Fundamental Concepts\* -2

## Embedded in SE/SW model components:

- The design of downstream processes during product design
- Timely and appropriate collaboration of all relevant stakeholders
- Focus on the customer's needs during product and process development
- Continuous and proactive identification and management of risk
- Focus on measurement and improvement of processes to develop and deliver the product





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(big picture)

→ **IPPD process areas**

IPPD in SE/SW

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# IPPD Process Areas

**A new Support process area, Organizational Environment for Integration (OEI)**

**An IPPD-specific Integrated Project Management (IPPD) process area (IPM (IPPD)) which adds two new specific goals**

**A new Project Management process area, Integrated Teaming (IT)**



# Organization Environment for Integration--OEI



# OEI Purpose

## Purpose

**To provide an IPPD infrastructure  
and manage people for integration.**



# OEI Specific Goals

## **SG 1: Provide IPPD Infrastructure**

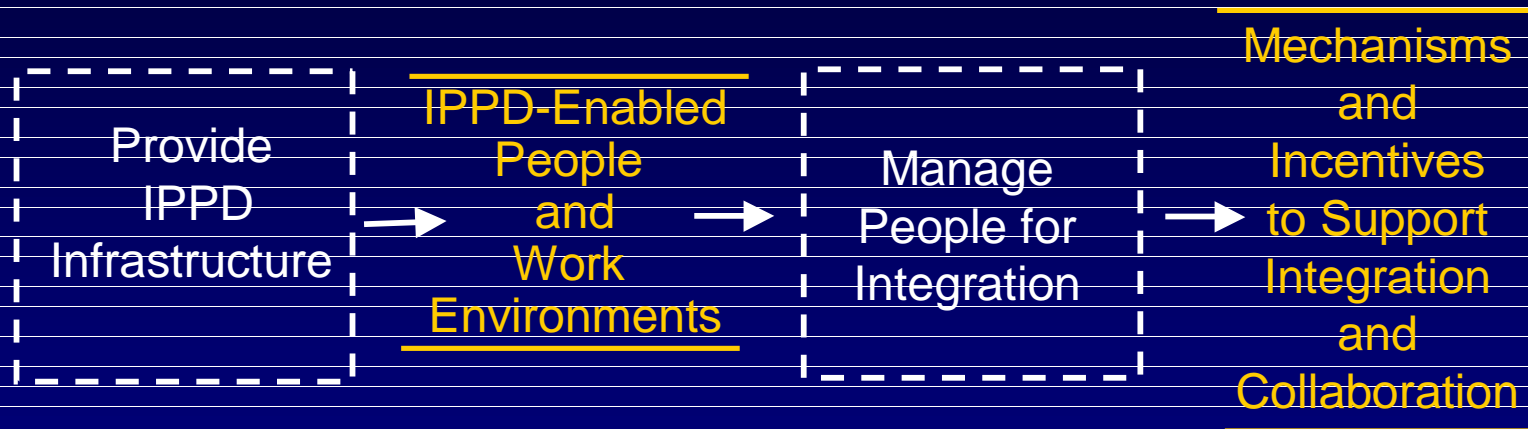
An infrastructure that maximizes the productivity of people and effects the collaboration necessary for integration is provided.

## **SG 2: Manage People for Integration**

People are managed to nurture the integrative and collaborative behaviors of an IPPD environment.

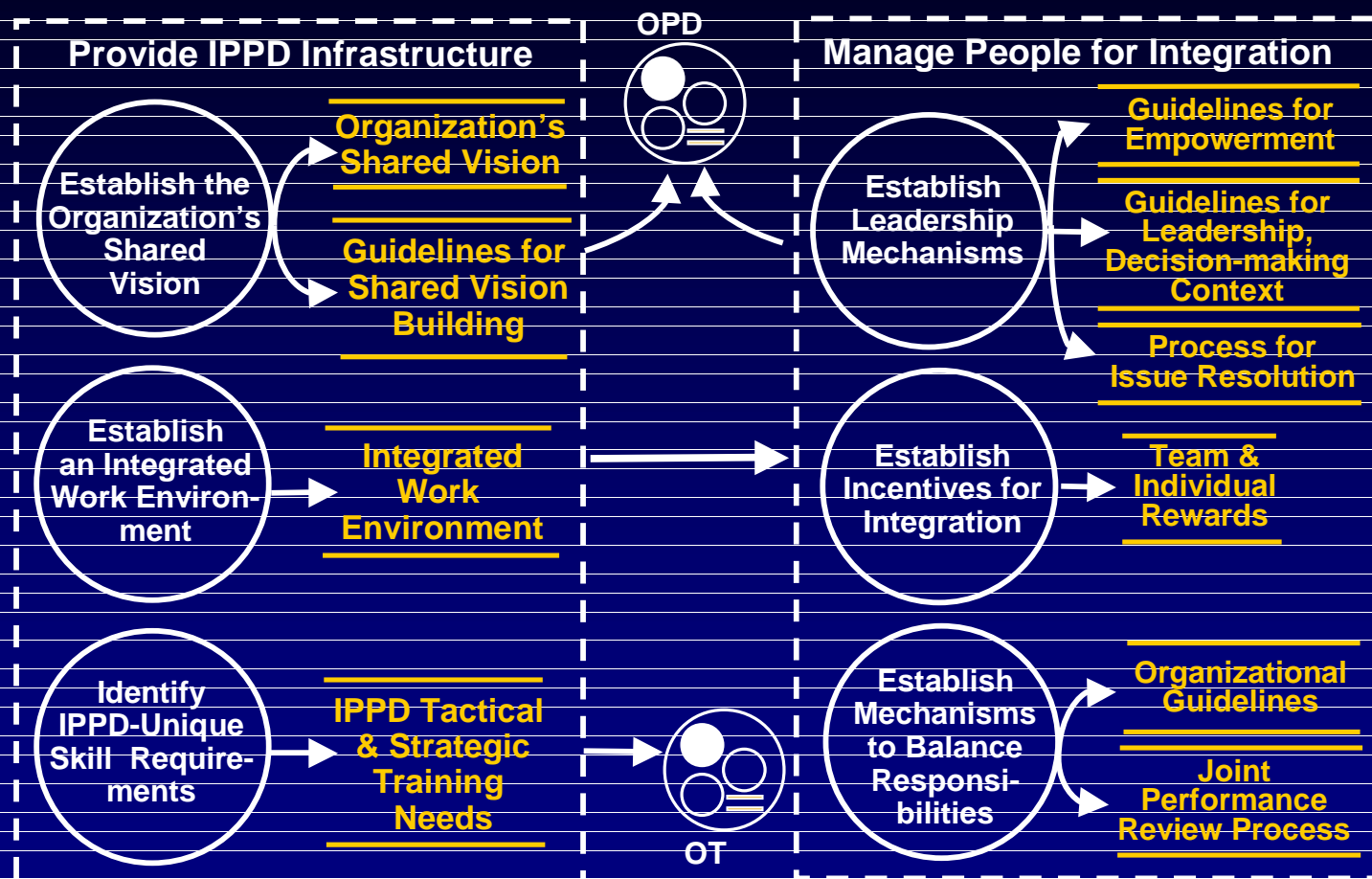


# OEI Context





# OEI Details





# Goals and Practices for OEI

## Specific Goals

## Specific Practices

### Provide IPPD Infrastructure

- Establish the Organization's Shared Vision
- Establish an Integrated Work Environment
- Identify IPPD-Unique Skill Requirements

### Manage People for Integration

- Establish Leadership Mechanisms
- Establish Incentives for Integration
- Establish Incentives to Balance Team and Home Organization Responsibilities





# Related Process Areas for OEI

## Organizational Process Definition (OPD)

- Establishing organization's set of standard processes and library of process assets

## Organizational Training (OT)

- Identifying training needs and providing the necessary training

## Integrated Project Management (IPPD)

- Managing stakeholder involvement, resolving coordination issues, establishing the project's shared vision, and organizing integrated teams



# OEI Summary - 1

**Establish and maintain a shared vision for the organization**

**Establish and maintain an integrated work environment that supports IPPD by enabling collaboration and concurrent development**

**Identify the unique skills needed to support the IPPD environment**



## OEI Summary - 2

**Establish and maintain leadership mechanisms to enable timely collaboration**

**Establish and maintain incentives for adopting and demonstrating integrative and collaborative behaviors at all levels of the organization**

**Establish and maintain organizational guidelines to balance team and home organization responsibilities**



# Integrated Project Management (IPPD)--IPM (IPPD)



# IPM (IPPD) Purpose

**Establish and manage the project and the involvement of the relevant stakeholders according to an integrated and defined process that is tailored from the organization's set of standard processes.**

**Establish a shared vision for the project and organize integrated teams.**



# IPM (IPPD) Specific Goals -1

## **SG 1: Use the Project's Defined Process**

The project is conducted using a defined process that is tailored from the organization's set of standard processes.

## **SG 2: Coordinate and Collaborate with Relevant Stakeholders**

Coordination and collaboration of the project with relevant stakeholders is conducted.



# IPM (IPPD) Specific Goals - 2

## **SG 3: Use the Project's Shared Vision**

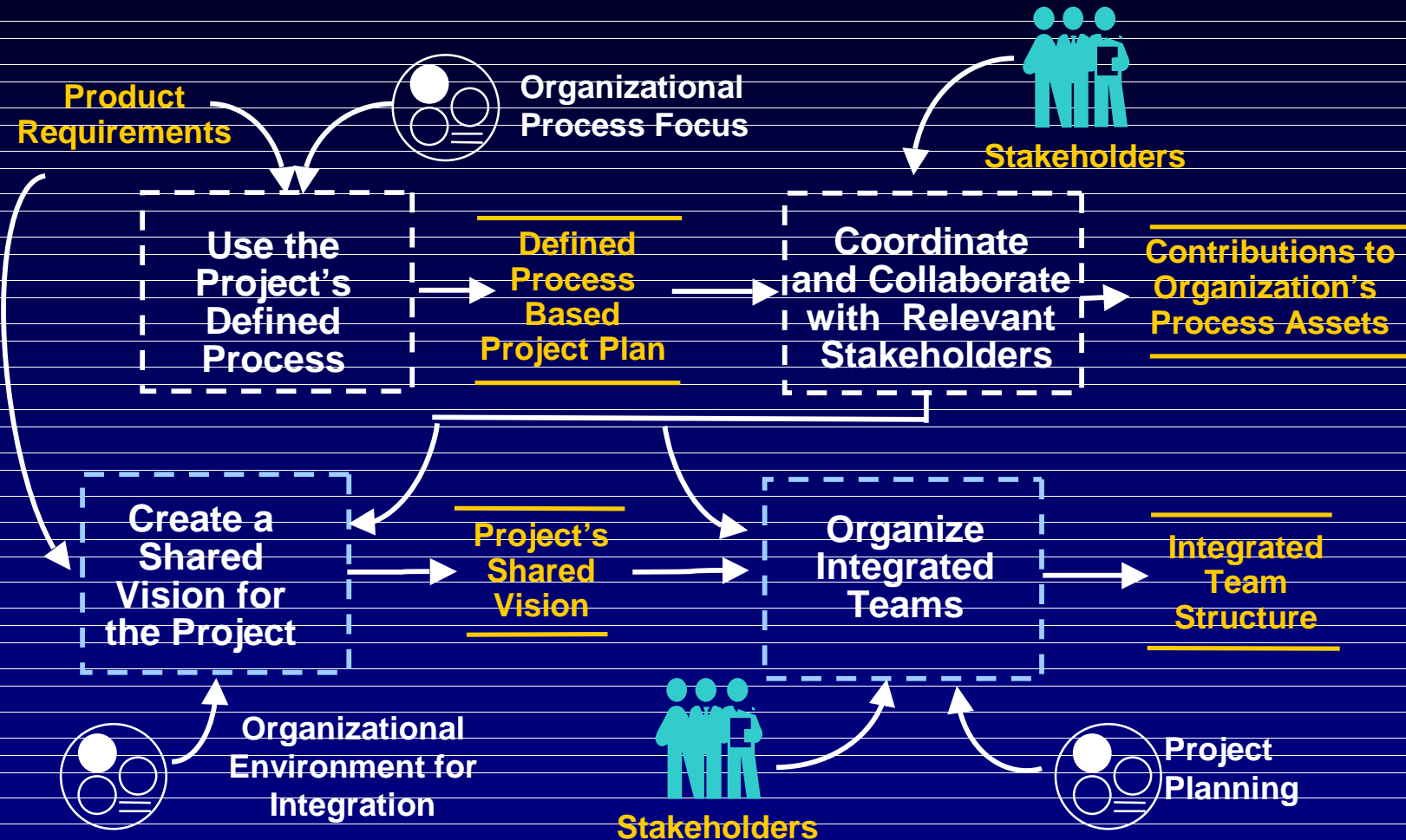
The project is conducted using the project's shared vision.

## **SG 4: Organize Integrated Teams**

The integrated teams needed to execute the project are identified, defined, structured, and tasked.



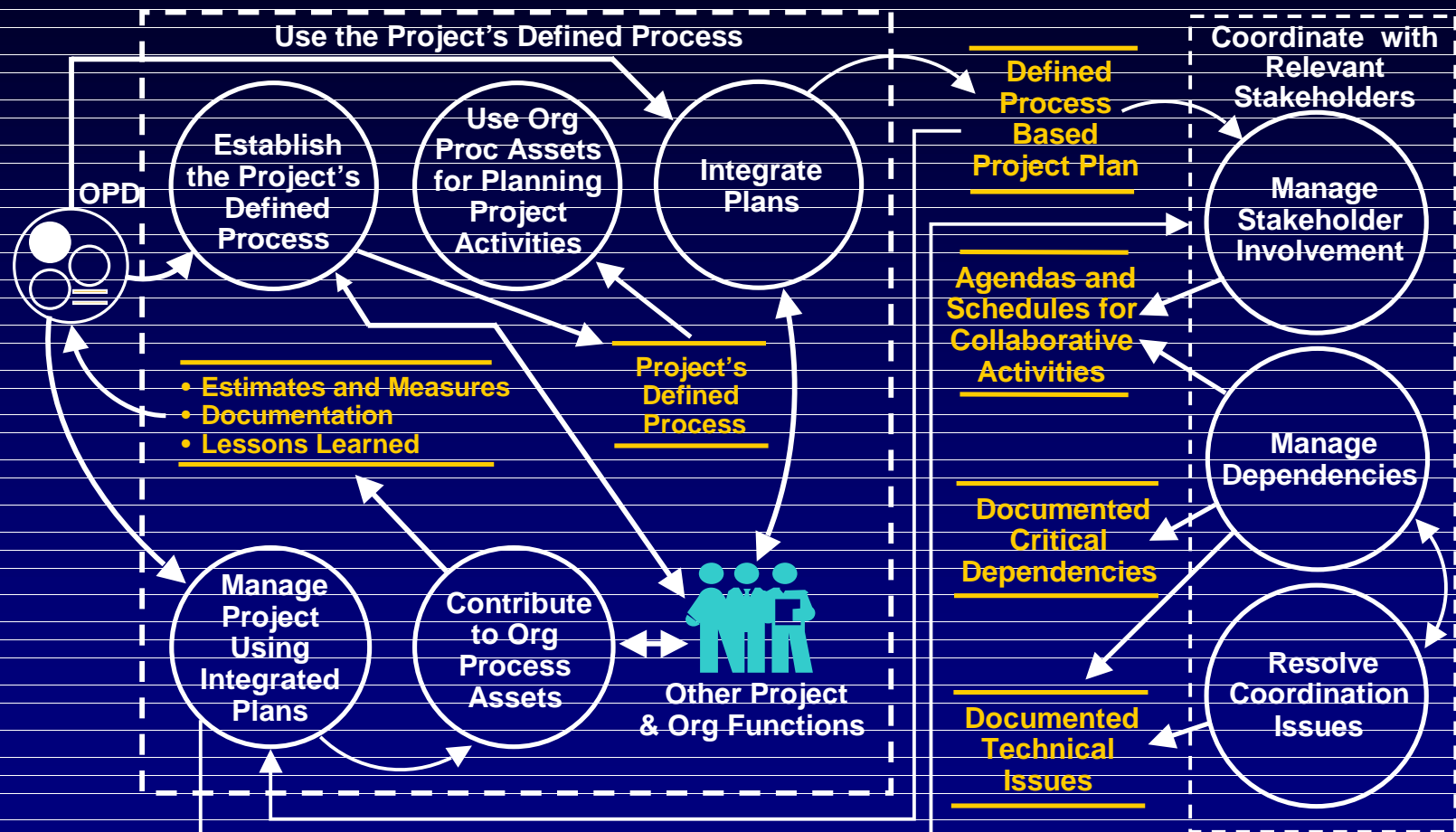
# IPM (IPPD) Context





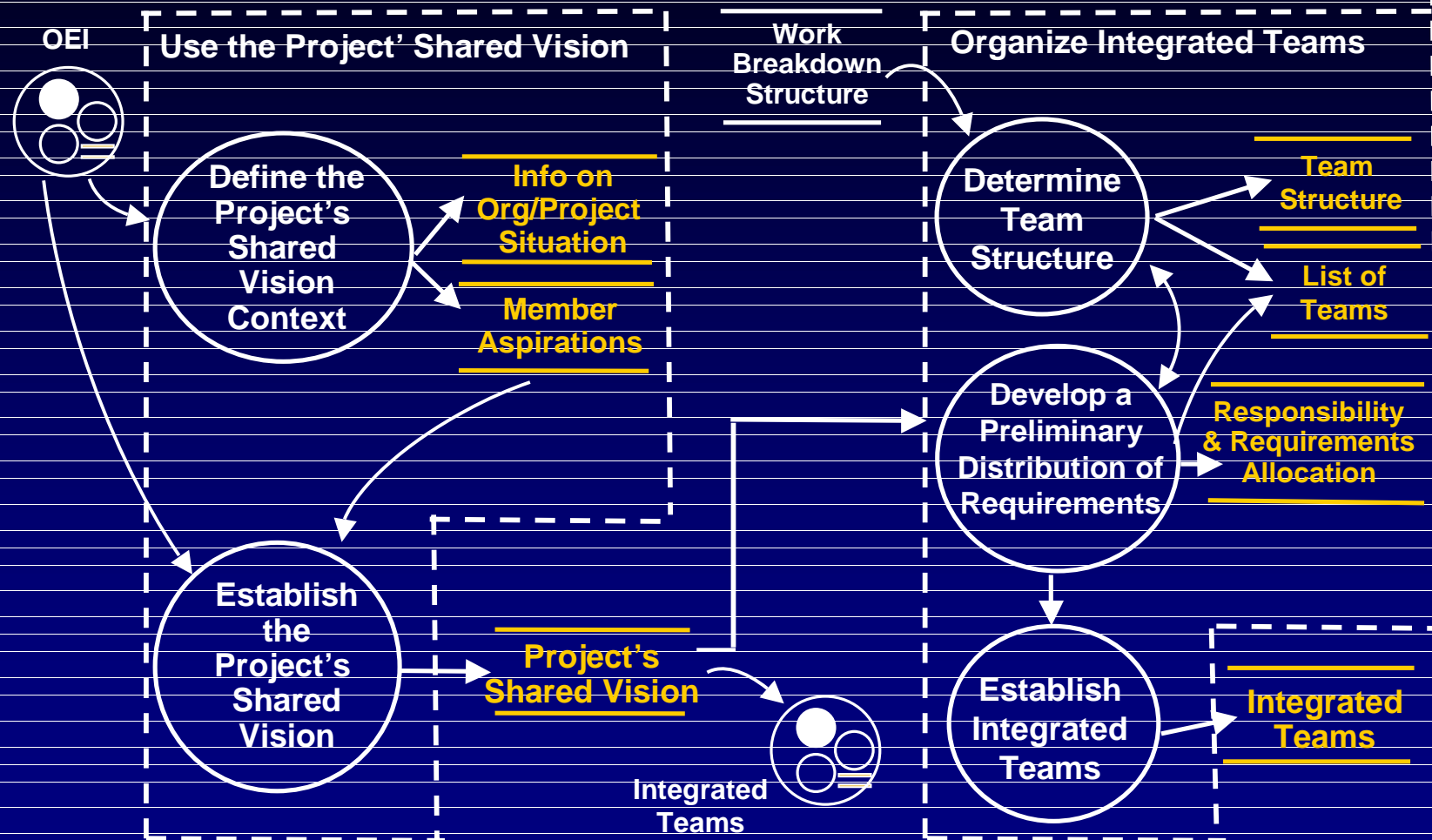


# IPM (IPPD) Details - 1





## IPM (IPPD) Details - 2





# Goals and Practices for IPM (IPPD) - 1

## Specific Goals

**Use the  
Project's  
Defined  
Process**

## Specific Practices

- Establish the Project's Defined Process
- Use Organizational Assets for Planning Project Activities
- Integrate Plans
- Manage Project Using Integrated Plans
- Contribute to Organizational Process Assets

**Coordinate and  
Collaborate  
with Relevant  
Stakeholders**

- Manage Stakeholder Involvement
- Manage Dependencies
- Resolve Coordination Issues



# Goals and Practices for IPM(IPPD) - 2

## Specific Goals

## Specific Practices

### Shared Vision

- Define the Project's Shared Vision Context
- Establish the Project's Shared Vision

### Organize Integrated Teams

- Determine Team Structure for a Project
- Develop a Preliminary Distribution of Requirements to Integrated Teams
- Establish Integrated Teams



# Related Process Areas for IPM (IPPD)

## Organizational Environment for Integration

- Creating the work environment and the organization's shared vision and managing people for integration

## Integrated Teaming

- Establishing and maintaining a team



# IPM (IPPD) Summary -1

**Tailor the project's defined process from the organization's set of standard processes**

**Manage the project using integrated plans**

**Use and contribute to the organization's process assets**

**Enable each relevant stakeholder's unique expertise and concerns to be identified and considered during the development of the product**



## IPM (IPPD) Summary -2

**Ensure that the relevant stakeholders associated with the project coordinate their efforts in a timely manner to**

- Address system requirements, plans, objectives, issues, and risks
- Make their commitments
- Identify, track, and resolve issues



## **IPM (IPPD) Summary -3**

**Establish a shared vision for the project aligned with the shared vision of the organization**

**Determine the structure of the teams that will execute the project's tasks**

**Decide on the allocation of responsibilities to the teams**

**Establish the teams**

**Manage the performance of the team structure**





# Integrated Teaming (IT)



# State of the Practice of Integrated Product Teams (IPT) - 1\*

- A recent SEI study of the state of the practice of Integrated Product Teams (IPTs) found that the use and effectiveness of IPTs varies across the DoD and defense industry.
- An IPT is now a recognizable concept across the DoD.
- The implementation of IPTs in the DoD is an integral part of a much larger, interdependent system of process improvements.

\*Integrated Product Teams: A State-of-the-Practice Study, Report of an SEI Internal Research and Development Project, Graettinger et al, 2000.



## State of the Practice of Integrated Product Teams (IPT) - 2\*

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- When IPTs are implemented well, they provide excellent outcomes, along the lines predicted in DoD guidance and training briefings.

One interviewee said: *“Best experience I’ve had!”*

- It is not trivial to implement IPTs well, and there are often problems.



# State of the Practice of Integrated Product Teams (IPT) - 2\*

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## These mechanisms enable successful IPTs:

- Setting and maintaining objectives
- Creating teams
- Supporting teams
- Improving communication
- Tools supporting communication



# Integrated Teaming Purpose

**To form and sustain an integrated team for the development of work products.**



# Integrated Teaming Specific Goals

## **SG 1: Establish team composition.**

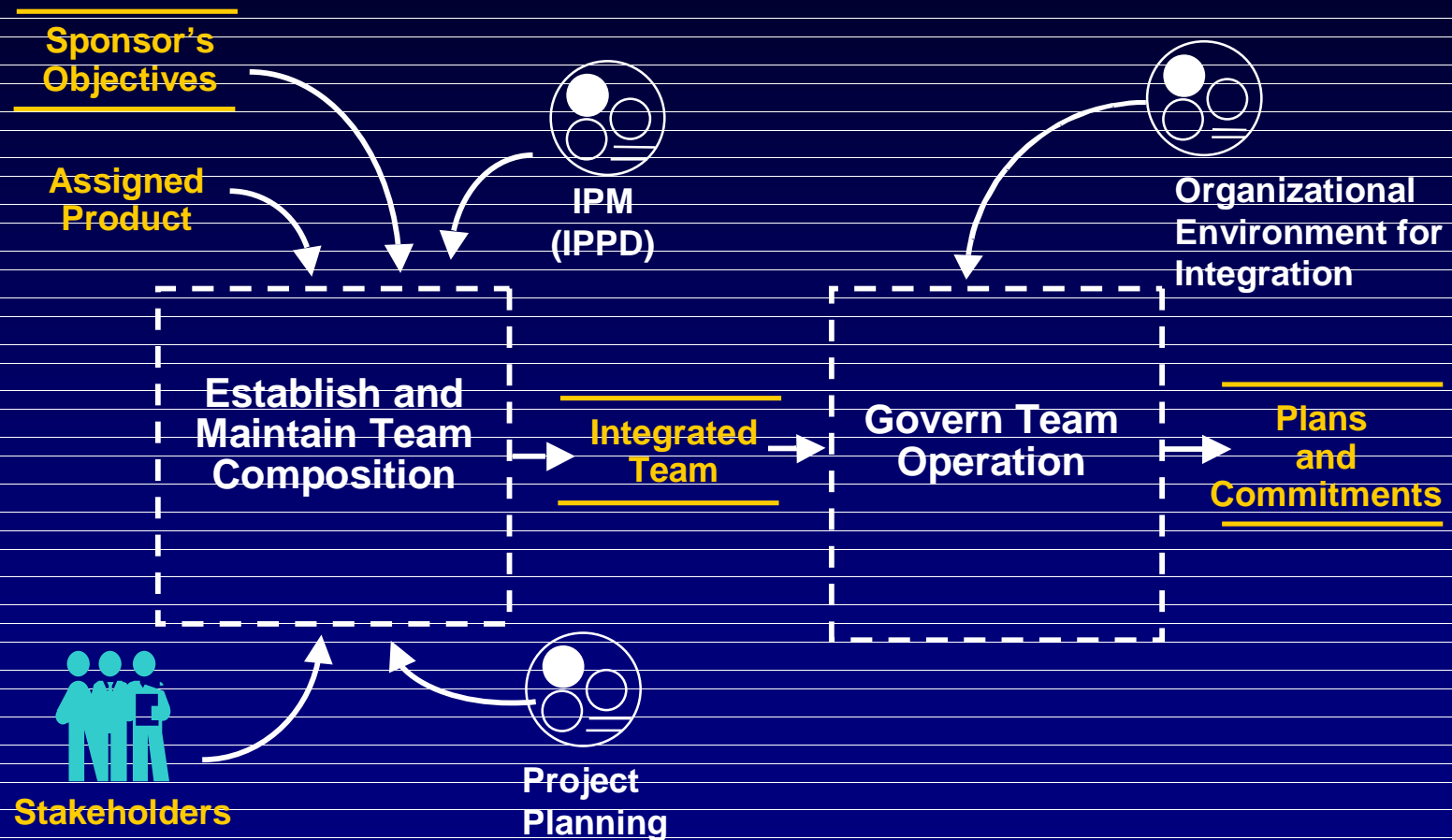
Team composition that provides the knowledge and skills required to deliver the team's product is established and maintained.

## **SG 2: Govern team operation.**

Operation of the integrated team is governed according to established principles.

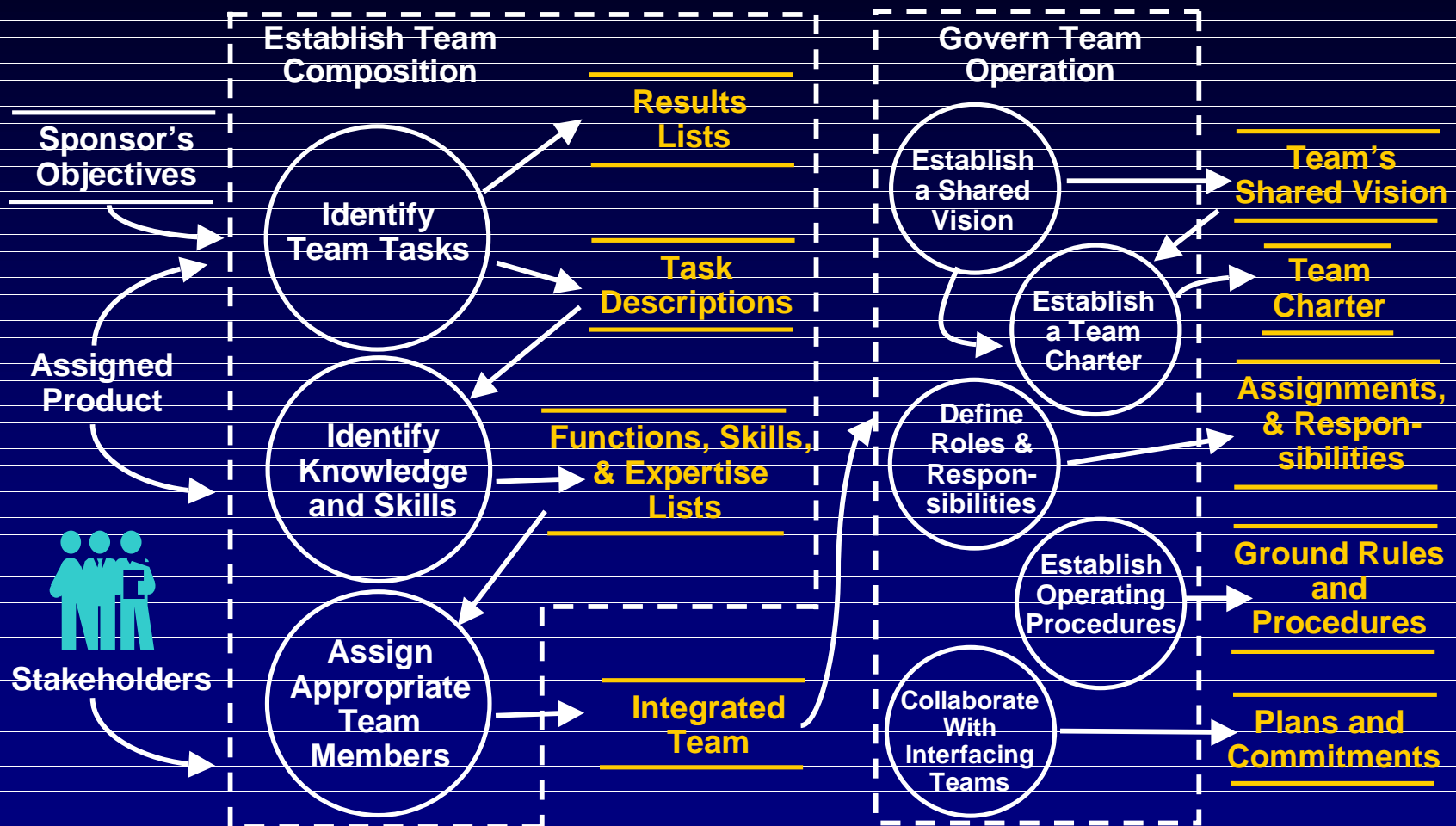


# Integrated Teaming Context





# Integrated Teaming Details







# Goals and Practices for IT

## Specific Goals    Specific Practices

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### Establish Team Composition

- Identify Team Tasks
  - Identify Knowledge and Skills Needed
  - Assign Appropriate Team Members
- 

### Govern Team Operation

- Establish a Shared Vision
- Establish a Team Charter
- Define Roles and Responsibilities
- Establish Operating Procedures
- Collaborate among Interfacing Teams



# Related Process Areas for IT

## Integrated Project Management (IPPD)

- Coordinating and collaborating with relevant stakeholders and considering IPPD
- Creating a project shared vision and organizing integrated teams for project execution

## Project Planning

- Planning for project execution (tasks, knowledge, skills) within an IPPD environment with integrated teaming

## Organizational Environment for Integration

- Establishing and maintaining an integrated work environment and managing people for integration



# Integrated Teaming Summary - 1

**Identify and define the team's internal tasks to generate the team's expected output**

**Identify the knowledge, skills and functional expertise needed to perform the team's tasks and assign the appropriate personnel to be team members**

**Establish and maintain the team's shared vision and the team charter**



# Integrated Teaming Summary - 2

**Define and maintain the roles and responsibilities of each team member**

**Establish and maintain integrated team operating procedures and collaboration among interfacing teams**



# IPPD Process Areas Summary

## Practices in OEI

- establish physical infrastructure and organizational management practices for IPPD
- enable the integrated teamwork needed for successful project completion

## Integrated Teams are a core component of IPPD

- the structure of integrated teams is established through practices in IPM (IPPD)
- each specific team is formed and sustained through practices in IT

**Shared visions** for the organization, the project, and the team are developed, one in each IPPD PA



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**How does IPPD work in the CMMI?**

**(big picture)**

**IPPD process areas**

**→ IPPD in SE/SW**

**Summary**



# IPPD Fundamental Concepts\*

## Embedded in SE/SW model components:

- Design of downstream processes during product design
- Timely and appropriate collaboration of all relevant stakeholders
- Focus on the customer's needs
- Proactive identification and management of risk
- Measurement and improvement of development processes



# Fundamental concepts embedded - 1

## Design of downstream processes during product design

- the concurrent design of products and processes is implicit throughout the model, in the definition of 'work product'
- design of downstream processes is implicit in references to 'life-cycle' requirements -- specifically, SP 1.2-1 Establish Life-Cycle Model Descriptions
- in an IPPD environment, this is done by an integrated team





# Fundamental concepts embedded - 2

## Timely and appropriate collaboration of all relevant stakeholders

- Generic Practice 2.7 Identify and involve relevant stakeholders applies to every PA in CMMI
- in IPPD, stakeholders are included on the integrated team



# Fundamental concepts embedded - 3

## Focus on the customer's needs during product and process development

- Generic Practice 4.1 Establish quality objectives ... based on customer needs... applies to every PA
- requirements are based on customer needs; products are validated against customer needs; process and product standards are frequently imposed by the customer; work products are delivered to customers; customers can be relevant stakeholders
- in IPPD, integrated teams perform the above



# Fundamental concepts embedded - 4

## Proactive identification and management of risk

- Risk Management is an SE/SW PA
- specific risks associated with IPPD processes and teaming are identified in amplifications throughout the model



# Fundamental concepts embedded - 5

## Measurement and improvement of development processes

- measurement activities are detailed in the Measurement and Analysis PA
- the improvement of development processes is one of the 'raison d'être' of all versions of the CMMI



# Process Management Process Areas

## Processes used for IPPD emphasize

- parallel rather than serial development
- concurrent development of products and related processes from all phases of the product life cycle and from both business and technical functions
- effective teamwork

## Organizational Training includes skills needed for pursuing IPPD

- cross-functional training
- leadership training
- interpersonal and team skills training



# Project Management Process Areas

## Project plans and resources

- are team plans and resources
- involve all integrated teams
- include commitment of all team members

## Supplier selection considers

- willingness to participate in integrated teams using IPPD
- commitment to IPPD



# Engineering Process Areas

## Requirements development and alternative selection

- include the participation of stakeholders
- from all phases of a product's life cycle
- from both technical and business functions

## Development of alternatives and 'final' design

- include concurrent development of appropriate processes across the product life cycle

## Product integration, verification and validation strategies

- are developed concurrently and iteratively with the product and product component designs



# CMMI IPPD Definition

**IPPD provides a systematic approach to product development that achieves a timely collaboration of relevant stakeholders throughout the product life cycle to better satisfy customer needs.**





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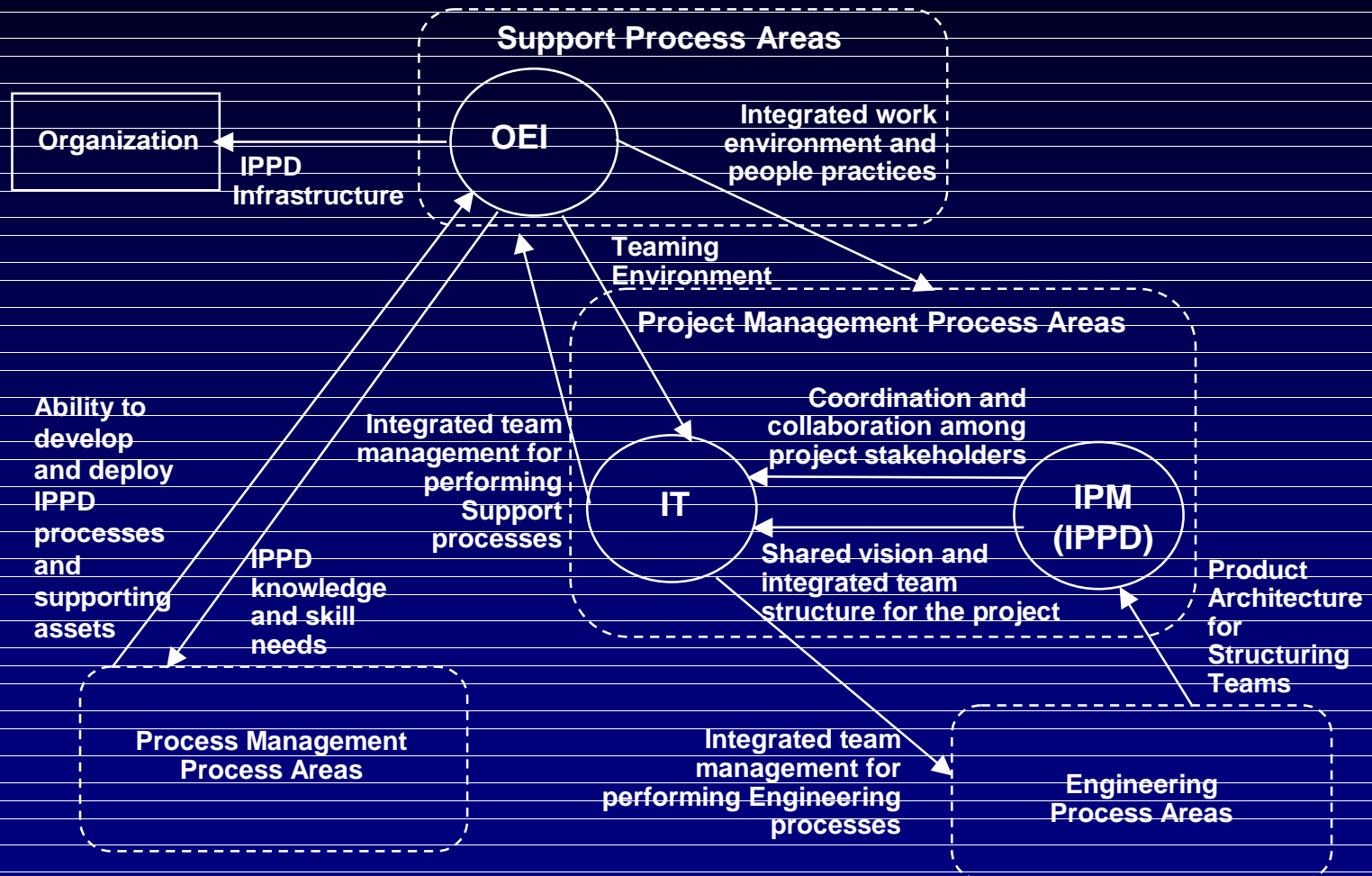
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**→ Summary**



# IPPD Environment





# Summary

**CMMI-SE/SW/IPPD v. 1.02 was released for public review on December 12, 2000**

**Change requests submitted by February 28, 2001 will be considered for next release (Version 1.1 due December 2001)**

**Available at**

**<http://www.sei.cmu.edu/cmmi/>**